

Application for United States Letters Patent

For

**METHOD OF GENERATING A PUBLIC LONG CODE MASK**

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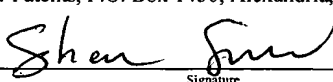
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## METHOD OF GENERATING A PUBLIC LONG CODE MASK

### BACKGROUND OF THE INVENTION

#### 1. FIELD OF THE INVENTION

5 This invention relates generally to telecommunication, and, more particularly, to a wireless telecommunication system.

#### 2. DESCRIPTION OF THE RELATED ART

10 The coverage area of a wireless communication system is typically divided into a number of cells, which may be grouped into one or more networks. Mobile units, such as mobile telephones, personal data assistants, Global Positioning System devices, desktop or laptop computers, and the like, located in each cell may access the wireless communications system by establishing a wireless communication link with a base station associated with the cell. For example, a mobile telephone may initiate communication with a base station by providing a signal on an access channel. The base station may then use the received access channel signal to  
15 establish the wireless communication link between the mobile unit and the base station on a separate traffic channel.

20 At any given time, each base station may be expected to maintain concurrent wireless communication links with numerous mobile units. To reduce interference between the concurrent wireless communication links, the base station and the mobile units in the wireless communication system modulate signals transmitted on the assigned traffic channels using a predetermined code that uniquely identifies the mobile unit. For example, in a wireless communication system operating according to the CDMA 2000 standard, a public long code mask may be used to differentiate reverse link transmissions, *i.e.* from the mobile unit to the base station, over different traffic channels. The public long code mask is typically a 42-bit-long  
25 mask including two bits that indicate the type of the long code mask (public or private), an additional eight bits that provide signaling information such as the method used to form the long

code mask, and a 32-bit electronic serial number (often referred to using the acronym ESN) assigned to the mobile unit.

The proliferation of various types of mobile units has begun to exhaust the supply of 32-bit electronic serial numbers. To accommodate the growing number of mobile units, many practitioners have proposed replacing the 32-bit electronic serial number with a 56-bit mobile equipment identifier (often referred to using the acronym MEID: Mobile Equipment IDentifier). Although the need to transition to the 56-bit mobile equipment identifier is widely accepted and incorporated in the IS-2000 standard, no consensus has developed regarding how to modify the aforementioned 42-bit public long code mask to accommodate the proposed 56-bit mobile equipment identifier. One possible technique is to map the 56-bit mobile equipment identifier to a 24-bit value and then to concatenate an 8-bit value to the 24-bit value to form a 32-bit pseudo-ESN. However, this pseudo-ESN method does not result in a sufficient number of distinct public long code masks to prevent an undesirable number of collisions between mobile units.

The public long code mask may alternatively be generated using a base station identifier (sometimes referred to using the acronyms BS\_ID or BASE\_ID), a Walsh code, and a 9-bit string (sometimes referred to as a PN offset) that differentiates one base station from a neighboring base station. If a call is in handoff, all handoff legs need to use the same public long code mask, *i.e.* a public long code mask assigned by the primary leg. However, the public long code mask needs to be changed whenever a new primary assumes control of the call, *e.g.* when a primary transfer occurs, so that the old primary may reuse the Walsh code once the old primary drops off the call. Otherwise, two mobile units on two different calls may be assigned the same public long code mask, which may cause crosstalk between the two concurrent wireless communication links.

During an inter-frequency handoff from a first frequency (F1) to a second frequency (F2) within a sector, the public long code mask generated by a base station typically changes after the inter-frequency hand-off. For example, a mobile unit that has established a first wireless communication link with a first base station (BS1), with a first PN offset (PN\_Offset1), on a first carrier frequency (F1) using a first Walsh code (W1) may have a public long code mask of [BS1, PN\_Offset1, W1]. The inter-frequency handoff moves the first wireless communication link from the first carrier frequency (F1) to the second carrier frequency (F2) in the same sector (BS1, PN\_Offset1). The first base station (B1) assigns the first wireless communication link a second Walsh code (W2). Thus, the new public long code mask may be [BS1, PN\_Offset1, W2].

The new public long code mask may be transmitted to the mobile unit either during or after the inter-frequency handoff. If the new public long code mask is transmitted to the mobile unit during the time-critical handoff phase, the additional time delay needed to transmit the public long code mask may increase the number of handoff failures. On the other hand, if the new public long code mask is not transmitted to the mobile unit until after the inter-frequency handoff, the number of collisions may be increased. For example, immediately after the handoff, but before the new public long code mask has been transmitted to the mobile unit, the second carrier frequency (F2) will also be using the public long code mask [BS1, PN\_Offset1, W1]. In the meantime, a second wireless communication link that has previously been established in the same sector on the second carrier frequency (F2) may be using the Walsh code (W1). The base station identifier and pilot PN offset should be the same for all carriers in the same sector, so it is very likely that the public long code mask of the second wireless communication link may be [BS1, PN\_Offset1, W1]. Consequently, it is very likely that the first wireless communication link will collide with the second wireless communication link during the inter-frequency handoff.

The present invention is directed to addressing the effects of one or more of the problems set forth above.

### **SUMMARY OF THE INVENTION**

5           In one embodiment of the instant invention, a method is provided for generating a public long code mask. The method includes generating a code mask for coding transmissions over a traffic channel based on at least one frequency differentiator indicative of a frequency range, at least one band class differentiator indicative of a band class, and at least one traffic channel differentiator indicative of a traffic channel.

10           In another embodiment of the present invention, a method is provided for performing an inter-frequency hand-off. The method includes receiving an indication that an inter-frequency handoff from a first frequency range to a second frequency range is to be initiated and generating, in response to receiving the indication, a code mask for coding transmissions over a traffic channel based on at least one frequency differentiator indicative of the second frequency range, at least one band class differentiator indicative of a band class, and at least one traffic channel differentiator indicative of a traffic channel. The method also includes performing the inter-frequency handoff from the first frequency to the second frequency and transmitting the code mask.

20           In yet another embodiment of the present invention, a method is provided for coding transmission. The method includes receiving a code mask for coding transmissions over a traffic channel based on at least one frequency differentiator indicative of a frequency range, at least one band class differentiator indicative of a band class, and at least one traffic channel differentiator

indicative of a traffic channel. The method also includes transmitting over the traffic channel using the received code mask.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

5           The invention may be understood by reference to the following description taken in conjunction with the accompanying drawings, in which like reference numerals identify like elements, and in which:

10           Figure 1 conceptually illustrates a portion of a code mask, such as a public long code mask, which may be used to differentiate between various transmissions over channels of one or more wireless communication links.

15           Figure 2 conceptually illustrates a first exemplary embodiment of a public long code mask, such as the code mask shown in Figure 1.

            Figure 3 conceptually illustrates a second exemplary embodiment of a public long code mask, such as the code mask shown in Figure 1.

20           Figure 4 conceptually illustrates a third exemplary embodiment of a public long code mask, such as the code mask shown in Figure 1.

            Figure 5 conceptually illustrates a fourth exemplary embodiment of a public long code mask, such as the code mask shown in Figure 1.

Figure 6 conceptually illustrates a fifth exemplary embodiment of a public long code mask, such as the code mask shown in Figure 1.

While the invention is susceptible to various modifications and alternative forms, specific  
5 embodiments thereof have been shown by way of example in the drawings and are herein  
described in detail. It should be understood, however, that the description herein of specific  
embodiments is not intended to limit the invention to the particular forms disclosed, but on the  
contrary, the intention is to cover all modifications, equivalents, and alternatives falling within  
the spirit and scope of the invention as defined by the appended claims.

#### **DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS**

Illustrative embodiments of the invention are described below. In the interest of clarity,  
not all features of an actual implementation are described in this specification. It will of course  
be appreciated that in the development of any such actual embodiment, numerous  
15 implementation-specific decisions should be made to achieve the developers' specific goals, such  
as compliance with system-related and business-related constraints, which will vary from one  
implementation to another. Moreover, it will be appreciated that such a development effort  
might be complex and time-consuming, but would nevertheless be a routine undertaking for  
those of ordinary skill in the art having the benefit of this disclosure.

Figure 1 conceptually illustrates a portion 100 of a code mask 101, such as a public long  
code mask, which may be used to differentiate between various transmissions over channels of  
one or more wireless communication links. The use of code masks is well known in the art of  
wireless communication and, in the interest of clarity, will not be discussed further herein.  
25 Although only the portion 100 of the code mask 101 is shown in Figure 1, persons of ordinary

skill in the art will appreciate that the code mask 101 may include other elements not shown in the Figure 1. For example, as will be discussed in detail below, the code mask 101 may include a type indicator, a signal indicator, a base station indicator, and the like.

5           The portion 100 includes a band class differentiator 105. Wireless communication links may be formed according to the specifications of a variety of band classes, such as the North American cellular band, cellular personal communication service (PCS) band, 1800-MHz band (IMT) band, and the like. In one embodiment, the band class differentiator 105 indicates a band class being used to form the wireless communication link. In one embodiment, the band class  
10 differentiator 105 is a five-bit number indicating the band class. For example, a band class differentiator 105 for the North American cellular band may be 00000.

          The code mask portion 100 also includes a frequency range differentiator 110. In one embodiment, the frequency range differentiator 105 is a channel number indicative of a particular  
15 frequency range that may be used to form a channel of a wireless communication link. For example, the North American cellular band is divided into a plurality of frequency ranges, such as the frequency range of about 869-894 MHz, which may be used to form a wireless communication link. Each frequency range in the North American cellular band is indicated by a channel number ranging from 1-1024. Accordingly, the frequency range differentiator 105 in  
20 this embodiment may be a string of at least 10 bits. However, any desirable number of bits may be used to form the frequency range differentiator 105. For example, the frequency range differentiator 105 may be an 11-bit string.

          The traffic channel differentiator 115 is also included in the code mask portion 100. In  
25 one embodiment, the traffic channel differentiator 115 is a Walsh code. The use of Walsh codes



to differentiate traffic channels is well-known in the art of wireless communication and, the interest of clarity, will not be discussed further. However, persons of ordinary skill in the art will appreciate that the present invention is not limited to Walsh codes and, and alternative embodiments, other traffic channel differentiators 115 may be used.

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The probability of a collision during an inter-frequency handoff from one base station to another may be reduced by forming the code mask 101 using the band class differentiator 105, the frequency range differentiator 110, and the traffic channel differentiator 115. For example, if a mobile unit establishes a first wireless communication link with a first base station that implements the present invention, the first base station may assign a public long code mask of [BC1, F1, W1] corresponding to a first band class (BC1), a first carrier frequency (F1), and a first Walsh code (W1). The inter-frequency handoff to a second base station moves the first wireless communication link to a second carrier frequency (F2), where the first wireless communication link is assigned a second Walsh code (W2). Thus, the new public long code mask may be [BC2, F2, W2].

15

Immediately after the handoff, but before the new public long code mask has been transmitted to the mobile unit, the first wireless communication link on the second carrier frequency (F2) may still be using the public long code mask [BC1,F1,W1]. However, even if a second concurrent wireless communication link in the same band class (BC1) on the second carrier frequency (F2) has been assigned the same Walsh code (W1), the public long code mask of the first wireless communication link [BC1,F1,W1] will be different than the public long code mask of the second wireless communication link [BC1,F2,W1]. Consequently, the probability that transmissions on the first wireless communication link will collide with transmissions on the

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second wireless communication link during the inter-frequency handoff is reduced relative to other proposed public long code mask assignment schemes, such as discussed above.

5 In one embodiment, the original Walsh code (W1) is not immediately reused on the first carrier frequency (F1) after the primary leg of the first carrier frequency is no longer in the call. Instead, the original Walsh code may be assigned to a new wireless communication link after a predetermined time delay. For example, a guard timer may be provided such that the original Walsh code (W1) becomes available for re-assignment after the guard timer expires. The exact duration of the time delay, or the guard timer, is a matter of design choice and may depend on  
10 many factors. For example, the duration of the guard timer should be long enough to allow the first wireless communication link to substantially finish establishing the new public long code mask with the mobile station. Accordingly, the probability of collisions between the first wireless communications link and other concurrent wireless communication links on the first carrier frequency during the inter-frequency handoff may be reduced in embodiments that  
15 include the guard timer.

Figures 2-6 conceptually illustrate five alternative embodiments of the code mask 101. In practice, the number and/or order of the bits in the portion 100 of the code mask 101, as well as the number and/or order of bits in other portions (not shown in Figure 1) of the code mask 101,  
20 may vary depending on the particular implementation of the code mask 101. Accordingly, the embodiments shown in Figures 2-6 are intended to be exemplary of the variety of possible implementations of the code mask 101. However, persons of ordinary skill in the art will appreciate that an almost infinite number of possible bit arrangements are possible, and thus the embodiments shown in Figure 2-6 are not intended to limit the present invention.

Figure 2 conceptually illustrates a first exemplary embodiment 200 of a public long code mask, such as the code mask 101 shown in Figure 1. The first exemplary embodiment 200 includes a band class 205, a channel number 210, and a Walsh code 215. The band class 205 includes a plurality of bits that may be used to differentiate between possible band classes. For example, the band class 205 may comprise five bits indicative of a particular band class, such as the North American cellular band. The channel number 210 includes a plurality of bits used to differentiate between ranges of frequencies that may be used to form a wireless communication channel. For example, the channel number 210 may comprise 11 bits indicative of a frequency range used to form a wireless communication channel. The Walsh code 215 includes a plurality of bits indicative of a corresponding plurality of Walsh codes, which may be used to differentiate between traffic channels. For example, the Walsh code 215 may comprise eight bits.

The first exemplary embodiment 200 may also include additional bits indicative of other characteristics of the base station, the mobile unit, the traffic channel, and the like. For example, the first exemplary embodiment 200 includes a PN offset 220. The first exemplary embodiment 200 may also include one or more filler bits 225. In various alternative embodiments, the filler bits 225 may include bits indicative of the type of the long code mask (public or private), signaling information such as the method used to form the long code mask, and the like. As indicated in Figure 2, the first exemplary embodiment 200 may be formed by concatenating the band class 205, the channel number 210, Walsh code 215 and, if present, the PN offset 220 and/or the one or more filler bits 225.

Figure 3 conceptually illustrates a second exemplary embodiment 300 of the public long code mask, which comprises the same elements as the first exemplary embodiment 200, but provides these elements in a different order. In particular, the second exemplary embodiment 300

may be formed by concatenating the one or more filler bits 225 (if present), the band class 205, the channel number 210, Walsh code 215 and, if present, the PN offset 220. Persons of ordinary skill in the art will appreciate that the ordering of the elements in the second exemplary embodiment 300 is merely intended to illustrate one possible alternate ordering. In various  
5 alternative embodiments, the elements may be concatenated in any desirable order.

Figure 4 conceptually and illustrates a third exemplary embodiment 400 of the public long code mask. The third exemplary embodiment 400 differs from the second exemplary embodiment 300 in that the PN offset 220 has been encoded (*e.g.* using a block cipher such as  
10 DES), permuted (*e.g.* using a pair-wise independent permutation), or otherwise functionally manipulated to form the third exemplary embodiment 400, as indicated by the function  $f(\text{PN Offset})$  405. Although the third exemplary embodiment 400 shows encoding, permutating, or manipulating of the PN offset 220, persons of ordinary skill in the art will appreciate that any portion of (or combination of) the one or more filler bits 225 (if present), the band class 205, the  
15 channel number 210, Walsh code 215 may be encoded, permuted, or otherwise functionally manipulated to form the third exemplary embodiment 400.

Figure 5 conceptually and illustrates a fourth exemplary embodiment 500 of the public long code mask. The fourth exemplary embodiment 500 differs from the second exemplary  
20 embodiment 300 in that the Walsh code is multiplexed with the PN offset in a predetermined manner to form a multiplexed PN offset/Walsh code 505. Persons of ordinary skill in the art will appreciate that any desirable multiplexing scheme may be used to form the multiplexed PN offset/Walsh code 505. Moreover, any desirable portion of (or combination of) the band class 205, the channel number 210, the filler bits 225, and the PN offset/Walsh code 505 may be

500.

Figure 6 conceptually and illustrates a fifth exemplary embodiment 600 of the public long  
code mask. The fifth exemplary embodiment 600 differs from the fourth exemplary embodiment  
500 in that the multiplexed PN offset/Walsh code has been divided into first and second portions  
605, 610 of the multiplexed PN offset/Walsh code. The first and second portions 605, 610 may  
be arranged in fifth exemplary embodiment 600 in a discontinuous manner, as shown in Figure 6.  
Moreover, persons of ordinary skill in the art will appreciate that the band class 205, the channel  
number 210, the filler bits 225, and any other desirable part of the fifth exemplary embodiment  
600 may also be arranged in a discontinuous manner.

The particular embodiments disclosed above are illustrative only, as the invention may be  
modified and practiced in different but equivalent manners apparent to those skilled in the art  
having the benefit of the teachings herein. Furthermore, no limitations are intended to the details  
of construction or design herein shown, other than as described in the claims below. It is  
therefore evident that the particular embodiments disclosed above may be altered or modified  
and all such variations are considered within the scope and spirit of the invention. Accordingly,  
the protection sought herein is as set forth in the claims below.